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Patent Claims

1. An electromechanical connection between electronic circuit systems (10) and substrates (20), in which an electronic circuit system (10) and a substrate (20) are mechanically connected fixedly to one another, electrical connection elements (11, 21) which face one another on the electronic circuit system (10) and the substrate (20) are in each case connected in an electrically conductive manner by means of microcapsules (23-1, 23-2), and in which the microcapsules (23-1, 23-2) are formed by grains (23-1) which are coated with a dielectric (23-2) and at least in part are electrically conductive, characterized in that the dielectric (23-2) of the microcapsules (23-1, 23-2) is broken open at least on its areas which face the electrical connection elements (11, 21), and at the correspondingly exposed areas of the grains (23-1) an electrically conductive soldered joint (25 to 28) is formed in each case between the exposed areas of the grains (23-1) and the electrically conductive connection elements (11, 21), which in each case face these areas, of the electronic circuit system (10) and of the substrate (20), respectively.
2. The electromechanical connection as claimed in claim 1, characterized in that the mechanically fixed connection between the electronic circuit system (10) and substrate (20) is made by means of an adhesive (24).
3. The electromechanical connection as claimed in claims 1 and 2, characterized in that the adhesive

(24) used is a polymer.

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4. The electromechanical connection as claimed in one of claims 1 to 3, characterized in that the micro-capsules (23-1, 23-2) are embedded in the adhesive (24).

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5. The electromechanical connection as claimed in claim 1,

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characterized in that the mechanically fixed connection between electronic circuit system (10) and substrate (20) is formed by a soldered joint between connection elements (11, 21) which are inactive in the intended electronic functioning of electronic circuit system (10) and substrate (20).

6. The electromechanical connection as claimed in one of claims 1 to 5, characterized in that electrically conductive metal grains (23-1) which are selected from the group of metals consisting of copper, nickel, silver, gold and are covered with a dielectric (23-2) are used as microcapsules (23-1, 23-2).
7. The electromechanical connection as claimed in one of claims 1 to 5, characterized in that electrically conductive metal grains (23-1) of a solderable metal alloy, which are covered with a dielectric (23-2), are used as microcapsules (23-1, 23-2).
8. The electromechanical connection as claimed in one of claims 1 to 5, characterized in that metallized, insulating grains (23-1) which are covered with a dielectric (23-2) are used as microcapsules (23-1, 23-2).
9. The electromechanical connection as claimed in claim 8, characterized in that silver-plated tin oxide grains are used as metallized, insulating grains (23-1).
10. The electromechanical connection as claimed in one of claims 6 to 9, characterized in that an insulating enamel is used as the dielectric (23-2)

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of the microcapsules (23-1, 23-2).

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11. The electromechanical connection as claimed in claim 10,

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characterized in that a soldering flux is used as the insulating enamel.

12. The electromechanical connection as claimed in one of claims 1 to 11, characterized in that the electrically conductive soldered joint (25 to 28) between connection elements (11, 21) of electronic circuit system (10) and substrate (20) is formed by soldering of layers of solder (25, 27) which are provided on the connection elements (11, 21) to form intermetallic phases (26, 28) comprising material of the electrically conductive grains (23-1) of the microcapsules (23-1, 23-2) and the layers of solder (25, 27).
13. The electromechanical connection as claimed in claim 12, characterized in that a metal selected from the group consisting of tin, indium and gallium is used as the material for the layers of solders (25, 27).
14. The electromechanical connection as claimed in claim 12, characterized in that a metal alloy with a low melting point is used as the material for the layers of solder (25, 27).
15. The electromechanical connection as claimed in claim 13 or 14, characterized in that the layers of solder (25, 27) are layers of tin which have been deposited selectively and without using electric current.
16. The electromechanical connection as claimed in one of claims 1 to 15, characterized in that a metallic material which is matched to the metallic material of the conductive grains (23-1) of the microcapsules (23-1, 23-2) is used as material for

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the connection elements (11, 21) of electronic circuit system (10) and substrate (20).

17. The electromechanical connection as claimed in claim
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characterized in that copper or nickel is used as material for the connection elements (11, 21).

18. The electromechanical connection as claimed in one
5 of claims 1 to 17, characterized in that a single layer of microcapsules (23-1, 23-2) of uniform size embedded in a polymer film are provided.
19. The electromechanical connection as claimed in one
10 of claims 1 to 5, characterized in that electrically conductive metal grains (23-1) which are covered with an insulating enamel (23-2) and at least in part consist of a solder metal are used as microcapsules (23-1, 23-2).
20. The electromechanical connection as claimed in claim
15 19, characterized in that the electrically conductive grain (23-1) of the microcapsules (23-1, 23-2) consist entirely of solder metal.
21. The electromechanical connection as claimed in claim
20 19 or 20, characterized in that a solder metal selected from the group consisting of tin, indium, gallium is used for the electrically conductive grains (23-1).
22. The electromechanical connection as claimed in claim
25 19 or 20, characterized in that a soft-solder alloy is used for the electrically conductive grains (23-1).
23. The electromechanical connection as claimed in one
30 of claims 19 to 22, characterized in that a solderable metal is used for the connection elements (11, 21) of electronic circuit system (10) and
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substrate (20).

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24. The electromechanical connection as claimed in claim 23, characterized in that a metal selected from the group consisting of copper, nickel, silver, gold is used as the solderable metal for the connection elements (11, 21).
25. The electromechanical connection as claimed in claim 19, characterized in that the electrically conductive grains (23-1) of the microcapsules (23-1, 23-2) are formed from an electrically conductive metal core which is covered with a solder material.
26. The electromechanical connection as claimed in claim 25, characterized in that copper is used as material for the electrically conductive metal core.
27. The electromechanical connection as claimed in claim 25 and/or 26, characterized in that tin is used as solder material for the covering of the core.
28. The electromechanical connection as claimed in one of claims 1 to 27, characterized in that the electrically conductive grains (23-1) of the microcapsules (23-1, 23-2) have a diameter of the order of magnitude of 10 μm , preferably less than 10 μm .
29. The electromechanical connection as claimed in claim 27, characterized in that the tin covering of the core has a thickness of the order of magnitude of 200 nm.
30. The electromechanical connection as claimed in one of claims 1 to 18, characterized in that the

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layers of solder which are applied to the connection elements (11, 21) have a thickness of the order of magnitude of 10 μm , preferably less than 10 μm .

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31. A method for producing the electromechanical connection as claimed in one of claims 1 to 30, characterized in that, after microcapsules (23-1, 23-2) embedded in an adhesive (24) or a polymer film have been introduced between electronic circuit system (10) and substrate (20), the microcapsules (23-1, 23-2) between the connection elements (11, 21) of the circuit system (10) and of the substrate (20) are compressed under such a force that the dielectric (23-2) on electrically conductive grains (23-1) situated between connection elements (11, 21) which face one another is broken open, and the soldered joint (25 to 28) in each case between those areas of the grains (23-1) which face the connections (11, 21) and the connections (11, 21) is produced by diffusion soldering.
32. The method as claimed in claim 31, characterized in that layers of solder metal (25, 27) are applied to connection elements (11, 21) in a thickness which is such that, during a diffusion-soldering process between metals of the electrically conductive grains (23-1) or grains (23-1) in the form of metallized insulators and the solder metal, the solder metal is completely converted into an intermetallic phase (26, 28).
33. The method as claimed in claim 31, characterized in that, when using microcapsules (23-1, 23-2) whose electrically conductive grains (23-1) consist entirely of solder metal, and connection elements (11, 21) which are free of solder metal on electronic circuit system (10) and substrate (20),

the thickness of the connection elements (11, 21) is
selected in such a way that sufficient

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material is available for the transformation process during the diffusion soldering.

34. The method as claimed in claim 31, characterized in that, when using microcapsules (23-1, 23-2) whose electrically conductive grains (23-1) comprise an electrically conductive metal core covered with a solder metal, and connection elements (11, 21) which are free of solder metal on electronic circuit system (10) and substrate (20), the thickness of the connection elements (11, 21) and of the solder metal

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